

Distribution in Longitude.

1888 did not afford such an extreme example of concentration of energy in one district as was afforded by the great group of June 16, 1889, but the spotted area was by no means evenly distributed. The most prolific district was that, the centre of which lay in Long. 275° and Lat. -7° . On four distinct occasions a considerable outbreak occupied this region, but in no case did the group return a second time. Group 2052 was the largest group of the year; group 2066, the third in size: but the latter group appeared four rotations later than the former. That the disturbed district was the same was, however, shown by two shortlived and much smaller formations, which were seen in the intermediate rotations. This district embraced 28·4 per cent. of the entire spot-area of the year.

Three other localities contributed about 11 per cent. apiece. Of these one, and the most interesting, had its centre at Long. 298° and Lat. -5° ; seven groups, one of them the most permanent of the year, appearing in this district. Throughout 80° of the Sun's circumference the only spots observed lay in one or other of these two districts—*i.e.*, either close to Long. 275° , or close to Long. 298° . Another had its centre in Long. 163° , Lat. -12° . Four groups were seen here, two of them large, with an interval of three rotations between the two outbursts. The stability of the centre of disturbance in these three districts, of which I have given the positions, is very remarkable when contrasted with the intermittent character of the actual spot-formations, and the same thing was seen on a minor scale in several other regions. The three districts together comprised more than half the spotted area of the year, and formed the locale of fifteen out of the fifty-one separate groups; yet only in one case was an outbreak sufficiently vigorous to last out a complete rotation.

*Note on the Spot-group of 1890 August 25–September 5.
By E. W. Maunder.*

A fine group of sun-spots appeared on the east limb of the Sun on August 25 last. This was the second appearance of the group, which had been observed during the preceding rotation, and it was also seen again during the rotation following, its formation and dissolution taking place in the invisible hemisphere. It was at its second appearance that it attained its greatest size and beauty of detail, and it was at this time that it afforded a threefold example of an apparent rotation round each other of pairs of nuclei, which seemed to me sufficiently well marked to justify a record.

As the group drew away from the east limb it first showed itself, on August 26, as composed of three principal spots. The

following day it had greatly enlarged. Two spots, each of area about 50 millionths, led; then came a confused crowd of small faint spots, and, lastly, a large spot of area about 300, with very dark and distinct nuclei, divided into two principal parts—one to the north, a compact well-defined nucleus; the other to the south, less dark and defined, and interrupted by bright bridges. On August 28 the confused crowd of spots in the middle of the group had crystallised out into a number of well-developed spots, one of which, of irregular outline, was much larger than all the others put together. This spot possessed two large dark nuclei.

These three pairs of nuclei, the two leaders of August 27, and the double nuclei of the great central and following spots of the group, afforded the instances of apparent partial rotation to which I wish to draw attention.

The positions of the three pairs on the days of observation were as follows:—

Preceding Pair.

	<i>Preceding Spot.</i>		<i>Following Spot.</i>	
	Longitude.	Latitude.	Longitude.	Latitude.
Aug. 27	45° 4'	+ 21° 0'	43° 3'	+ 20° 4'
28	45° 7'	+ 20° 9'	44° 2'	+ 20° 5'
29	46° 1'	+ 20° 6'	45° 3'	+ 20° 4'
30	46° 4'	+ 20° 5'	45° 9'	+ 20° 6'
31	46° 9'	+ 20° 4'	46° 5'	+ 20° 1'

The two spots had coalesced by September 1.

Central Pair.

	<i>Preceding Nucleus.</i>		<i>Following Nucleus.</i>	
	Longitude.	Latitude.	Longitude.	Latitude.
Aug. 28	42° 1'	+ 21° 7'	41° 0'	+ 21° 1'
29	42° 8'	+ 21° 2'	42° 0'	+ 20° 7'
30	43° 6'	+ 21° 1'	42° 9'	+ 20° 4'
31	44° 2'	+ 21° 0'	44° 3'	+ 20° 2'
Sept. 1	45° 1'	+ 20° 8'	46° 3'	+ 20° 2'

This spot had coalesced with the combined spots of the preceding pair by September 1.

Following Pair.

	<i>Preceding Nucleus.</i>		<i>Following Nucleus.</i>	
	Longitude.	Latitude.	Longitude.	Latitude.
Aug. 27	35° 3'	+ 21° 9'	35° 1'	+ 22° 7'
28	34° 7'	+ 21° 9'	34° 3'	+ 22° 6'
29	34° 2'	+ 21° 8'	33° 7'	+ 22° 4'
30	33° 8'	+ 22° 0'	33° 2'	+ 22° 4'
31	33° 7'	+ 22° 1'	33° 0'	+ 22° 4'
Sept. 1	33° 7'	+ 22° 0'	32° 8'	+ 22° 2'

The two nuclei were in contact on September 1, and were re-divided later, but in a different manner, by several bright bridges. The axial line of the entire spot continued to move further round on September 2 and 3, in the same direction as before. No photograph of the Sun was taken at Greenwich on September 4.

The following table gives the heliographic position of the “centre of gravity” of the entire group during its second appearance :—

	Heliographic Longitude.	Heliographic Latitude.	Area of Umbræ.	Area of Whole Spots.
Aug. 25	43° 2'	+ 20° 5'	21	66
26	40° 6'	+ 20° 9'	35	71
27	38° 1'	+ 21° 6'	82	535
28	37° 9'	+ 21° 4'	107	724
29	37° 7'	+ 20° 9'	123	850
30	38° 4'	+ 21° 5'	131	867
31	38° 6'	+ 21° 6'	126	901
Sept. 1	39° 5'	+ 21° 3'	155	871
2	40° 7'	+ 21° 2'	119	837
3	42° 2'	+ 21° 1'	97	638
4		No photograph		
5	44° 2'	+ 20° 7'	51	417

The apparent sway of the group, first backward and then forward again, was due to the rapid growth of the great following spot on the first two or three days, succeeded by the development and forward motion of the central spot later on. By September 1 nearly the whole of the group had been absorbed into these two great spots; but, whilst drawing smaller spots towards themselves, they seemed to exercise a steady repulsion on each other, the average speed of separation being $1\frac{1}{4}$ °, or nearly 9,000 miles a day, from August 27 to September 3. Though this divergence was due much more to the forward motion of the first spot than to the retrogression of the second, the line joining their centres, which may be termed the axial line of the group, preserved an almost constant inclination of about 9° to the solar equator.

The following table gives the positions and areas of the two spots for each day of observation :—

	Following Spot.			Central Spot.			Area.
	Longitude.	Latitude.	Area.	Longitude.	Latitude.		
Aug. 26	35° 5'	+ 21° 7'	54	—	—	—	—
27	35° 2'	+ 22° 2'	299	39° 6'	+ 21° 3'	133	
28	34° 5'	+ 22° 2'	328	41° 0'	+ 21° 0'	232	
29	34° 5'	+ 21° 9'	475	42° 0'	+ 20° 8'	275	
30	33° 8'	+ 22° 2'	459	42° 9'	+ 20° 8'	335	
31	34° 0'	+ 22° 4'	500	44° 4'	+ 20° 8'	274	
Sept. 1	33° 7'	+ 22° 3'	394	46° 0'	+ 20° 4'	362	
2	33° 6'	+ 22° 3'	333	46° 4'	+ 20° 4'	446	
3	33° 7'	+ 22° 5'	217	46° 9'	+ 20° 3'	402	
4			No photograph				
5	32° 9'	+ 22° 5'	66	46° 5'	+ 20° 3'	347	

The following table gives the position-angle of the following nucleus of each pair as referred to the preceding nucleus :—

	Preceding Pair.	Central Pair.	Following Pair.
Aug. 27	106°	—	14°
28	105	299	30
29	104	302	40
30	78	315	56
31	53	17	67
Sept. 1	—	63	78

The rotation of the first pair was, therefore, in the opposite direction to that of the other two. In all three cases, however, the tendency of the movement was to bring spots from the outside of the group nearer towards its general axial line. The well-known tendency of spot-groups is to stretch themselves out in a straight line, which is generally nearly, but not quite, parallel to the equator. The present examples of seeming rotation are, therefore, more correctly examples of the tendency of all formations within a group to range themselves along the axial line, and of spots right and left of that line to move down towards it.

*Blackheath,
November 14, 1890.*

The Red Spot on Jupiter. By James E. Keeler, B.A.

As the letter of Mr. A. Stanley Williams, in the *Monthly Notices* of June 13, has doubtless directed the attention of many observers to the red spot on *Jupiter*, we may expect a large number of sketches and drawings which will aid in the discussion of the interesting question asked. I send a drawing of the planet, with this region near the centre of the disc, which was prepared from sketches, micrometer measures, and observations of transits of prominent markings, made with the 36-inch equatoreal of the Lick Observatory on the night of August 28. It has also been compared with photographs of *Jupiter*, made with the same instrument by Professor Holden.

But few observations of *Jupiter* have been made with the large telescope this summer, and I have not seen the dark spot to which Mr. Williams called attention (unless it should happen to be one of those shown in the drawing); but according to my past experience, all minor markings, on reaching the red spot, are pushed to one side and flow around it. The drawing which I send may be useful for comparison with others, and may possibly aid in identifying the spot in the modified form which it has doubtless assumed by this time. Mr. Barnard, who has observed *Jupiter* much more systematically than myself, thought the spot referred to by Mr. Williams was gradually dissipated on reaching the red spot. It may be that in flowing around the sides of the latter, its colour was so altered by compression into the narrower limits of the belts surrounding the spot, that it could no longer be recognised.

The accompanying drawing was made under favourable circumstances with a power of about 400. Mr. Barnard, who has lately made many micrometer measures and other observations of the principal markings with the 12-inch equatoreal, agrees with me in considering the drawing an accurate representation of the surface features of the planet at the time given, and it may therefore, as far as it goes, be taken to represent the observations of us both.

The aspect of *Jupiter* has undergone considerable changes during the past year. The long streamers of the equatorial zone, which last summer were the most characteristic feature of the appearance of the planet, seem to be disappearing, and only imperfect examples of them remain. The equatorial zone itself has lost much of its intense whiteness. One of the most striking features at present is the series of small dark spots on the north red belt. When first seen by Mr. Barnard last April they were black, or at least very dark and round; now they are a very deep red, and somewhat elongated in the direction of the belts. Two of these spots are shown in the drawing. The great red spot is of about the same dimensions as last year, and has still a dark shade at its following end, but the middle is whiter, and the